Comparative outcomes of primary autogenous fistulas in elderly, multiethnic Asian hemodialysis patients

Claude J. Renaud, MRCP (UK), FAMS,[a] Jackie Ho Pei, FRCS,[b] Evan J. C. Lee, FRCP, MD,[a] Peter A. Robless, FRCS,[b] and **Anantharaman Vathsala, FRCP, MD,[a]** *Singapore*

Background: **The number of elderly (≥65 years) end-stage renal disease (ESRD) patients on hemodialysis is rapidly increasing. Vascular access outcomes remain contradictory and understudied across different elderly populations. We hypothesized age might influence primary autogenous fistula use and outcomes in a predominantly diabetic multiethnic Asian ESRD population.**

Methods: **Demographic and clinical factors affecting fistula patency and maturation were retrospectively compared among patients with incident ESRD aged <65 and ≥65 years at a single center. Fistula patency was estimated by Kaplan-Meier curves with log-rank test comparison.**

Results: **We analyzed 280 primary fistulas (59% radiocephalic, 33% brachiocephalic, and 8% brachiobasilic) in this cohort consisting of 31.8% aged ≥65 years, 50% Chinese, 39% Malay, 42% women, and 70% diabetic. One- and 2-year primary and secondary patency in patients aged <65 vs ≥65 years were comparable: 41.3% vs 36.7% and 28.7% vs 24.4% (P = .547) and 57.7% vs 56.8% and 47.1% vs 47.2% (P = .990). On multivariate analysis, only non-Chinese, dialysis initiation with tunneled catheters, and surgical/endovascular interventions affected fistula survival hazard ratios (HR): 0.622 (95% confidence interval [CI], 0.43-1.00), 0.549 (95% CI, 0.297-0.841), and 2.503 (95% CI, 1.695-3.697), respectively. Nonmaturation and intervention rates were also similar at 56.7% vs 61.8% and 34% vs 32.2% at 3 and 6 months and 0.31 vs 0.36 per access year, respectively (P > .05). Females and tunneled catheters were the only risk factors for nonmaturation (HR, 1.568; 95% CI, 1.148-1.608, and HR, 1.623; 95% CI, 1.400-1.881, respectively).**

Conclusions: **A primary fistula strategy in incident elderly ESRD is feasible and does not result in inferior outcomes. Age should therefore not be a determinant for primary fistula creation. (J Vasc Surg 2012;56:433-9.)**

The elderly (aged ≥65 years) account for an increasing number of end-stage renal disease (ESRD) patients initiating hemodialysis. In Europe, they represent 39% to 70% of patients,[1,2] whereas in the United States, the figure is ~50%.[3] Two of Asia's largest hemodialysis populations also show a similar demographic trend: mean age is 67.2 years in Japan,[4] and 40% of Taiwanese ESRD incident patients are elderly.[5] In smaller but more multiethnic Singapore, the mean and median age of incident patients is 60 years and rising.[6]

The age epidemic has been paralleled by a high incidence of diabetic ESRD, coronary artery disease (CAD), and peripheral artery disease (PAD).[3,7] The elderly are also twice as likely to die within the first year of hemodialysis compared to the nonelderly.[8] It has hence been argued that prosthetic grafts and tunneled catheters (TCs) should be the primary vascular access of choice in this age group given the perceived lack of potential benefits of autogenous (arteriovenous) fistulas (AVFs).[2,9-11]

Vascular access clinical practice guidelines advocate universal primary distal AVFs but disregard the challenges and lack of consensus for AVFs in the elderly.[12,13] Retrospective studies have also produced contradictory results in different populations.[5,9,14,15]

The purpose of this single-center study therefore was to compare primary AVF outcomes among patients aged <65 and ≥65 years in an aging multiethnic Asian population known to have a high diabetic ESRD prevalence.[6] We hypothesized that patients aged ≥65 years would have higher AVF nonmaturation, failure, and salvaging interventions.

METHODS

Patients. This was a retrospective study of prospectively collected data on a cohort of consecutive incident ESRD patients initiating hemodialysis from January 1, 2008 through December 31, 2010 at a tertiary hospital in Singapore, and who received dialysis at satellite hemodialysis centers through October 31, 2011. We reviewed all primary AVFs created for dialysis during that period. Institutional review board approval was obtained for this study.

Inclusion and exclusion criteria. We excluded from analysis primary prosthetic grafts, patients aged <21 years, and those dialyzed exclusively by TCs or followed up at other institutions. Selected patients were divided into two

From the Division of Nephrology, Department of Medicine,[a] and the Division of Vascular Surgery, Department of Cardiac, Thoracic and Vascular Surgery,[b] National University Health System.

Author conflict of interest: none.

Reprint requests: Claude J. Renaud, Visiting Consultant, Division of Nephrology, Department of Medicine, National University Health System, Singapore 119074 (e-mail: renaudcj@hotmail.com).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214/$36.00

doi:10.1016/j.jvs.2012.01.063

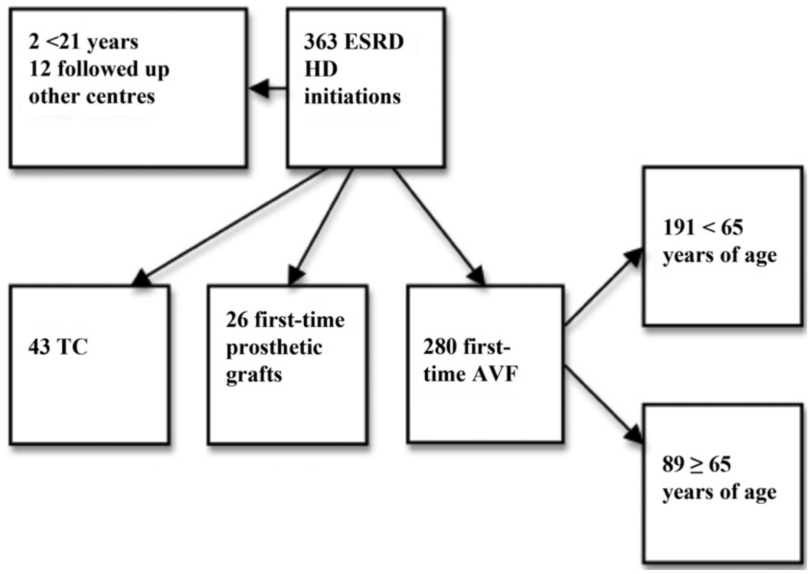

Fig 1. Cohort selection flow diagram shows patients with end-stage renal disease (*ESRD*) undergoing long-term hemodialysis (*HD*) with autogenous arteriovenous fistula (*AVF*) or HD only with a tunneled catheter (*TC*).

groups based on age at AVF creation: group A was aged <65 years and group B ≥65 years. Upper limb vein distensibility and arterial pulse but not digital pressure was assessed preoperatively. Duplex ultrasound venous mapping (VM) and arterial waveforms assessment were routinely performed by experienced vascular ultrasound technicians. Venographic VM was not performed to examine the central veins in patients with a history of TC use. Suboptimal vessels were classified as any vein with a diameter <2.5 mm with or without thrombus or stenosis in the outflow and/or an artery <2 mm with biphasic flow. However, the final decision for AVF selection was based on the individual surgeons' discretion and in keeping with clinical guidelines that stipulate a distal AVF-first approach.[12,13] Primary brachiobasilic transposed (BBT) AVFs (BBTAVFs) were mostly created in a two-stage procedure.

Fistulas were reviewed routinely at 7 days and at 8 to 12 weeks postoperatively and cannulated with two needles at 8 to 12 weeks if deemed clinically mature. AVFs that were difficult to cannulate were reassessed physically and by ultrasound imaging, and those with inflow or outflow stenoses, accessory veins, and >5 mm deep were revised endovascularly or surgically. Also assessed were patients referred for arm edema, hand ischemia, prolonged cannulation site bleeding after dialysis, low blood flow (<200 mL/min), high venous pressure (>150 mm Hg), access flow <400 mL/min, or recirculation >5% based on routine Transonic monitoring (Transonic Systems Inc, Itheca, NY) available in 60% of dialysis centers.

Data collection. Baseline demographic information and patient and AVF characteristics were retrieved from clinical notes and the hospital electronic database. Each AVF was assigned a nonmaturation risk score of ≤3 or >3, which denotes a 35% and 50% risk of nonmaturation, respectively, based on a validated scoring system.[16]

Study end points and definitions. Primary outcome measures were primary AVF patency (PP) and secondary patency (SP) as defined by Sidawy et al.[17] Patients were censored at the time of death, irreversible thrombosis, AVF ligation, transplantation, or peritoneal dialysis conversion. Secondary end points were nonmaturation, rate of surgical and endovascular interventions, and postpercutaneous transluminal angioplasty (PTA) SP, the latter according to Society of Interventional Radiology guidelines.[18]

Nonmaturation was defined as any created AVF that failed to develop well enough to be cannulated with two needles and provide prescribed dialysis for at least six consecutive sessions or TC removal by 3 months postoperatively, or both. Catheter removal was used preferentially because often a significant delay occurred between the first needling and reliable use of the AVF. Fistulas created predialysis were considered mature if they were needled successfully at the time of dialysis initiation. Fistula-salvaging interventions consisted of PTA or stenting, or both, thrombolysis/thrombectomy, fistula superficialization, anastomotic revision, aneurysmal repair, revascularization procedures for steal syndrome, and ligation of competing accessory veins but not AVF ligation or purely diagnostic angiograms. A timely referral was defined as any first nephrology visit >6 months before hemodialysis initiation.

Statistical analysis. Categoric data are expressed as percentages and continuous data as means ± standard deviation or range and were compared using χ^2 analysis and the Student *t*-test or Mann-Whitney test, respectively. Kaplan-Meier analysis and log-rank test were used to estimate PP and SP. Cox regression analysis was used to determine

Table I. Baseline demographic and vascular access characteristics

Baseline characteristic[a]	*<65 years (n = 191)*	*≥65 years (n = 89)*	P
Age, years	52 ± 9	72 ± 5.00	
AVF follow-up, months	12 (0-89)	13 (0-43)	.84
Race			
Chinese	93 (48.7)	48 (53.9)	.80
Malay	78 (40.8)	31 (34.8)	
Female sex	77 (40.3)	40 (44.9)	.52
Diabetes mellitus	133 (69.6)	63 (70.8)	.89
Coronary artery disease	79 (41.4)	44 (49.4)	.21
Peripheral artery disease	34 (17.8)	20 (22.5)	.42
Antiplatelet medications[b]	84 (44)	48 (53.9)	.13
Clopidogrel	13 (6.8)	16 (18)	.09
Warfarin	4 (2.1)	1 (1.1)	.01
Late referral (<6 months)	55 (28.8)	20 (22.5)	.31
Maturation score[c]			
≤3	95 (49.7)	0	.02
>3	96 (50.3)	89 (100)	
Ultrasound vein mapping	164 (85.9)	75 (84.3)	.75
Suboptimal vessels	102 (53.4)	50 (56.2)	
AVF type			
Radiocephalic	112 (58.6)	54 (60.7)	
Brachiocephalic	66 (34.6)	27 (30.3)	.69
Brachiobasilic	13 (6.8)	8 (9.0)	
Access at HD initiation			
Mature pre-HD AVF	30 (15.8)	17 (19.1)	
Nonmatured AVF[d]	13 (6.8)	8 (10)	.61
Tunneled catheter	147 (77.4)	64 (71.9)	

AVF, Autogenous arteriovenous fistula; *HD,* hemodialysis.
[a]Continuous data are shown as mean ± standard deviation or median (range) and categoric data as number (%).
[b]Four patients in the <65 group and one in the ≥65 group were taking warfarin and are not included.
[c]Predictive maturation score based on Lok et al.[16]
[d]Nonmature or thrombosed pre-HD AVF and dialysis initiated with a tunneled catheter.

factors independently associated with AVF SP. Selected variables have been shown to influence vascular access outcomes in previous publications.[9,11,14-16] The level of significance was two-sided and set as $P < .05$. All analyses were conducted using SPSS 20 software (SPSS Inc, Chicago, Ill).

RESULTS

The study included 280 of 363 hemodialysis ESRD patients (Fig 1): 68.2% in group A (aged <65 years) and 31.8% in group B (aged ≥65 years). Patient characteristics are summarized in Table I.

PP and SP rates at 6, 12, and 24 months were comparable (Tables II and III, Fig 2). Patency rates based on AVF type also yielded similar results (Tables II and III). Inflow stenosis was the most common angiographic cause of PP loss (73.2% vs 56.7%), followed by outflow stenosis (25% vs 36.7%) and combined lesions (1.8% vs 6.7%) out of 56 and 30 angiographies in groups A and B, respectively (P = .202). AVF abandonment in group A was due to 77 thromboses (40.3%), comprising two perioperative, 10 ≤30 days postoperative, and 65 >30 days postoperative; four ligations (2.1%); five transplants (2.6%); and 13 deaths (6.8%). At the end of follow-up, 92 AVFs (48.2%) remained functional. In group B, AVFs were abandoned as the result of 35 thromboses (39.3%), comprising three perioperative, two ≤30 days postoperative, and 30 >30 days postoperative; two AVF ligations (2.2%); and 10 deaths (11.2%). At the end of follow-up, 42 (47.2%) AVFs remained patent. Cox regression multivariate analysis showed only dialysis initiation with a TC, Chinese ethnicity, and AVF-salvaging interventions were significantly associated with AVF survival (Table IV).

Nonmaturation was 57.6% in group A and 61.8% in group B (P = .518). Female sex and dialysis initiation with a TC were significant risk factors (Table V). Group B had a higher baseline predictive nonmaturation risk score (Table I), but neither age nor a risk score >3 were associated with nonmaturation. A higher but nonsignificant number of BBTAVFs failed to mature by 3 months than radiocephalic (RC) and brachiocephalic (BC) AVFs, largely as a result of a mean waiting time of 2.5 months for the second-stage procedure (76% vs 57% vs 58%, respectively; P = .79). Two BBTAVFs were created by a one-stage procedure and six were lost before superficialization could be done. Using a 6-month maturation cutoff gave lower but still comparable nonmaturation rates of 34% in group A vs 32.6% in group B (P = .811) and 33.1% in RCAVFs, 30.1% in BCAVFs, and 52.4% in BBTAVFs (P = .161). However, the effect of sex became nonsignificant at 6 months.

A total of 126 procedures were performed: 83 in group A and 43 in group B. Interventions per access year were 0.40 overall and 0.34 vs 0.36 in groups A and B, respectively (P = .512). The interventions performed are summarized in Table VI. Excluded were eight AVF ligations (six in group A and two in group B) and three diagnostic angiograms without PTA. Angioplasty technical failure (ie, residual stenosis >30% or failure to cross stenoses) was significantly higher in group B, at 20% (seven of 35) vs 0% (P = .00). SP at 1 and 2 years after PTA was similar: 77.4% vs 61.3% and 65.5% vs 51.5% in groups A and B, respectively (log-rank, P = .81). Three transbrachial artery PTAs in group A resulted in arterial pseudoaneurysm and all three were surgically repaired. Venous rupture occurred after outflow stenosis PTA in two patients in group A, with one patient (a BBTAVF) requiring stenting. Steal syndrome occurred in one RCAVF and two BCAVFs in group A and one RCAVF and one BBTAVF in group B. In all cases, the AVF was ligated after Doppler ultrasound imaging confirmed reduced antegrade flow in markedly diseased radial and ulnar arteries rendering them unamenable to revascularization or arterial PTA except for one BCAVF in group A, which underwent distal revascularization interval ligation. Four AVF infections occurred in group A and none in group B. Two BBTAVFs were treated conservatively, and two BCAVF abscesses were drained and ligated. No deaths were directly related to AVF creation or its complications. Deaths in groups A and B were comparable and due to infections (three vs four), malignancy (two vs one), cardiovascular complications (seven vs four), and dialysis withdrawal (one in each group; P = .316).

Table II. Primary patency of arteriovenous fistulas (*AVFs*)

Variable[a]	6 months, %		12 months, %		24 months, %		Median, %		P[b]
	<65 years	≥65 years	<65 years	≥65 years	<65 years	≥65 years	<65 years	≥65 years	
Overall, %	62.9 ± 3.5	62.9 ± 5.1	41.3 ± 3.6	36.7 ± 5.1	28.7 ± 3.6	24.4 ± 4.8	8.0	7.0	.547
AVF type, %									
Radiocephalic	61.8 ± 4.7	59.3 ± 6.7	40.2 ± 4.7	36.9 ± 6.6	28.1 ± 4.5	19.0 ± 6.1	9.0	7.0	.582
Brachiocephalic	69.2 ± 5.7	74.1 ± 8.4	45.4 ± 6.8	47.5 ± 9.7	31.1 ± 6.7	33.3 ± 9.7	8.0	11.0	.710
BBT	53.8 ± 13.8	50.0 ± 17.7	30.8 ± 12.8	15.4 ± 11.7	NA	NA	6.0	5.0	.392

BBT, Brachiobasilic transposed; *NA,* not applicable; %, denotes remaining patent AVF by Kaplan-Meier and log-rank analysis.
[a]Data are shown as the mean ± standard error.
[b]*P* value by log-rank analysis.

Table III. Secondary arteriovenous fistula (*AVF*) patency

Variable[a]	6 months		12 months		24 months		Median		P[b]
	<65 years	≥65 years	<65 years	≥65 years	<65 years	≥65 years	<65 years	≥65 years	
Overall, %	71.0 ± 3.3	73.0 ± 4.7	57.7 ± 3.6	56.8 ± 5.3	47.1 ± 3.9	47.4 ± 5.5	20.0	16.0	.990
AVF type %									
Radiocephalic	70.2 ± 4.4	72.1 ± 6.1	58.6 ± 4.7	55.0 ± 6.8	47.0 ± 5.1	46.8 ± 7.0	20.0	16.0	.820
Brachiocephalic	74.2 ± 5.3	77.7 ± 7.5	55.5 ± 6.2	70.2 ± 8.8	48.5 ± 6.7	55.5 ± 10.5	21.0	26.0	.370
BBT	53.8 ± 13.8	50.0 ± 17.7	44.9 ± 14.1	25.0 ± 15.3	44.9 ± 14.1	25.0 ± 15.3	9.0	5.0	.513

BBT, Brachiobasilic transposed; %, denotes remaining patent AVF by Kaplan-Meier and log-rank analysis.
[a]Data are shown as the mean ± standard error.
[b]*P* value by log-rank analysis.

The 89 elderly patients who had an AVF were compared with 20 elderly patients who were dialyzed solely by TCs but were excluded from the study cohort. Other than age (mean age, 72 vs 75 years; $P = .013$), TC exposure (median, 261 vs 73 days; $P = .011$), and mortality (12.8% vs 90%; $P = .001$), there was no significant difference in sex (60% vs 46% female), diabetes mellitus (70% vs 75%), CAD (50% vs 65%), PAD (22.5% vs 30.0%), late referrals (22.5% vs 25%), and catheter-related infections (0.68 vs 1.87/1000 catheter-days) between the AVF and TC-only cohorts, respectively. All-cause infections accounted for four of 10 deaths (40%) in the AVF group vs six of 18 deaths (33%) in the TC group ($P = .001$). More patients dialyzing exclusively by TC withdrew from dialysis (five vs one).

DISCUSSION

Our results are, to our knowledge, the first to show that primary AVFs have comparable rates of maturation, salvage interventions, complications, and survival in an elderly vs nonelderly multiethnic Asian ESRD population. They support published guideline recommendations on AVFs as the primary vascular access across all ages. They also highlight the more important and significant role of nonage clinical factors on AVF outcomes in this population.

A small number of observational studies have provided increasingly supportive evidence for an AVF-first approach in the elderly.[19-25] Positive findings have also been described in multiethnic cohorts with a very small number of Asian patients[15,26] and in a population with a 60% diabetic ESRD prevalence.[27] In a Chinese-only cohort solely consisting of RCAVFs, old age did not influence outcomes, but a combination of diabetes mellitus and old age did.[28] These results have, however, fueled rather than resolved the controversies regarding age and AVF suitability due to nonuniform definitions for "elderly" and outcome measures and biased vascular access selection. Our use of tighter definitions and selection criteria, to counter these shortcomings, resulted in apparently lower patency and maturation rates comparatively. More so, our use of the more conventionally accepted elderly definition of ≥65 years, as was the case in most publications,[15,19-22,26,27] while others used 70 years[9,23,24] or even 60 years,[25] makes direct comparison challenging.

Even in the series with an age cutoff of ≥65 years, we did find other methodologic differences. For instance, Lok et al's[15] use of a nonmaturation rate cutoff of 6 months and a more aggressive vascular access surveillance and intervention strategy, including the use of vascular access coordinators and mandatory access flow monitoring, would explain their overall nonmaturation rate of 11% and 1-year PP and SP of 65.1% vs 64.8% and 79.7% vs 75.1%, in the elderly vs the nonelderly, respectively. It is not surprising therefore that the intervention rate in their cohort was 0.81% and patency rates were higher. Indeed, from our own data, we showed that AVFs which had endovascular and/or surgical interventions had longer survival. Similarly, higher patency rates from Swindlehurst et al[26] (PP and SP at 1 year of 63% vs 54% and 65 % vs 61% among elderly and nonelderly, respectively) and Jennings et al[27] (PP and SP in elderly at 59.9% and 96.6% at 2 years, respectively) were based on

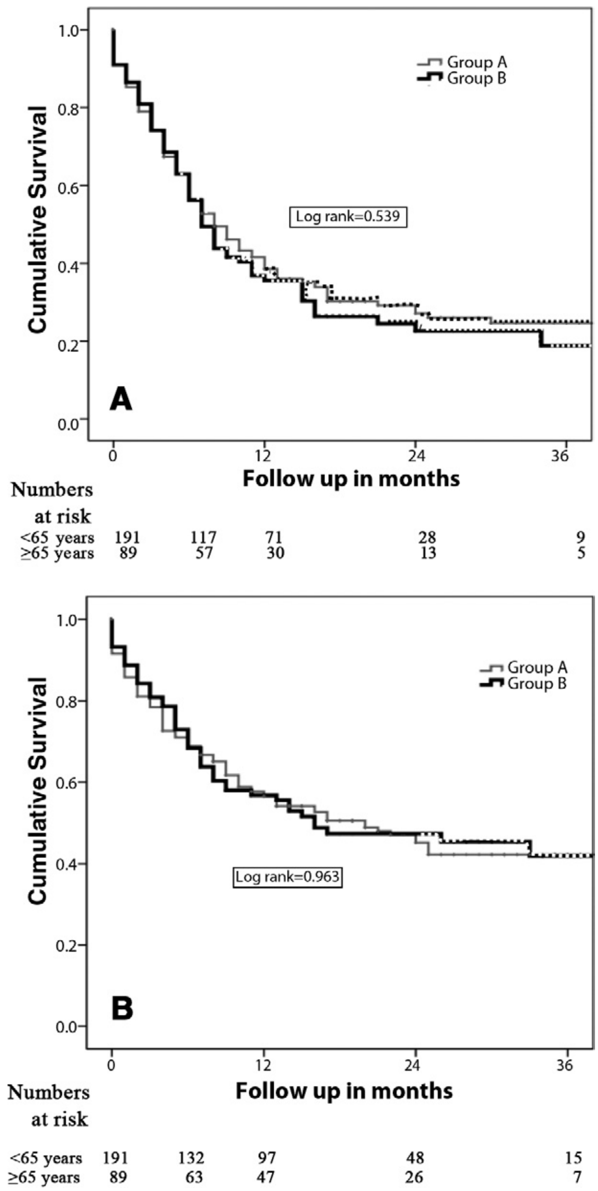

Fig 2. Kaplan-Meier patient survival curves for **(A)** primary patency and **(B)** secondary patency for patients aged <65 (*group A*) and ≥65 years (*group B*). Number at risk is indicated below graph. The *dotted lines* indicate when standard errors are >10% of the mean estimate and the curve becomes imprecise.

heterogeneous cohorts consisting of either both AVFs and grafts, both primary and secondary AVFs, or both upper limb and lower limb accesses, making comparisons difficult. Furthermore, only two of the studies mentioned whether both nonmature vascular accesses and primary failure cases were included in patency and maturation rate analysis.[15,26] Excluding failed cases, especially technical failures and early thromboses, has been shown to inflate outcome measures.[15-17]

The nonmaturation rate of our primary BBTAVF appears excessive compared with published rates of 5% to 40%.[29] However, our cohort consisted of only primary BBTAVFs, whereas published rates are based on both primary and secondary BBTAVFs, a much longer maturation cutoff of up to 1 year, and narrower definition of nonmaturation (ie, primary failure rate only).

Overall, nonmaturation has been reported as high as 67%, even under a randomized controlled setting,[30] and should not be looked at as a failure but rather as an opportunity to intervene and salvage the vascular accesses, as was elegantly demonstrated by Turmel-Rodrigues et al,[31] who showed lesions in those instances were predominantly inflow stenoses as in our cohort.

The effect of female sex on AVF maturation is well known.[11,15] The advantage enjoyed by men was, however, lost at 6 months, suggesting probably underlining hormonal, vessel reactivity, and platelet aggregation differences in women in the early postoperative period. The effect of starting dialysis with a TC on maturation may be due to the multiple hospitalizations and venipunctures

Table IV. Effect of independent variables on arteriovenous fistula (*AVF*) survival in patients aged <65 and ≥65 years

Variable	*HR (95% CI)*	P
Female sex	0.864 (0.613-1.220)	.407
Non-Chinese	0.622 (0.439-0.881)	.008
Diabetes mellitus	1.404 (0.915-2.155)	.121
Coronary artery disease	1.502 (0.912-2.472)	.110
Peripheral artery disease	0.757 (0.498-1.151)	.193
Early referral[a]	1.289 (0.857-1.940)	.223
HD initiation with TC	0.549 (0.297-0.841)	.009
Distal radiocephalic AVF	0.688 (0.367-1.288)	.242
AVF salvage interventions	2.503 (1.695-3.6970)	.000

CI, Confidence interval; *HD,* hemodialysis; *HR,* hazard ratio; *TC,* tunneled catheter.
[a]First nephrology ≥6 months before HD initiation.

Table V. Effect of independent variables on arteriovenous fistula (*AVF*) nonmaturation

Variable	*HR (95% CI)*	P
Age ≥65	1.127 (0.790-1.608)	.405
Female sex	1.568 (1.148-2.143)	.003
Non-Chinese	1.241 (0.965-1.596)	.090
Diabetes mellitus	1.054 (0.900-1.235)	.511
Coronary artery disease	1.089 (0.829-1.431)	.544
Peripheral artery disease	1.095 (0.669-1.792)	.760
Early referral[a]	1.394 (0.919-2.115)	.132
Antiplatelets	1.039 (0.806-1.339)	.808
Optimal vessels[b]	0.851 (0.608-1.189)	.410
Nonmaturation score >3[c]	1.094 (0.918-1.303)	.309
HD initiation with TC	1.623 (1.400-1.881)	.004
Distal radiocephalic AVF	0.933 (0.768-.133)	.537

CI, Confidence interval; *HD,* hemodialysis; *HR,* hazard ratio; *TC,* tunneled catheter.
[a]First nephrology ≥6 months before HD initiation.
[b]Veins ≥ 2.5 mm and/or arteries >2.0 mm based on sonographic venous mapping.
[c]Predictive maturation score based on Lok et al.[16]

Table VI. Procedures performed to maintain arteriovenous fistula (*AVF*) patency and survival

Type of procedure	*<65 years (No.)*	*≥65 years (No.)*
Angioplasty		
Inflow stenosis[a]	41	17
Outflow stenosis[b]	14	11
Combined stenosis	1	2
Stenting	2	2
Mechanical thrombolysis	1	0
Surgical intervention		
Anastomotic revision	5	3
Superficialization	2	1
Collateral ligation	6	2
Thrombectomy	1	2
DRIL	1	0
Others[c]	6	0

DRIL, Distal revascularization interval ligation.
[a]Arterial, anastomotic, and juxta-anastomotic stenosis.
[b]Includes one case of brachiocephalic and superior vena cava stenosis, both stented.
[c]Four aneurysm repairs and two fistula infection drainages.

associated with TC leading to poorer-quality vessels, and this agrees with the findings of Ramani et al.[32] The association between increased AVF survival and Chinese race (compared with non-Chinese) has not been reported before due to the small number of Chinese patients in previous multiethnic cohorts and could be a reflection of genetic differences or better preoperative vein preservation. A recent publication on ethnicity and vascular access outcomes attributed ethnic differences in vascular access outcomes to timeliness of predialysis nephrology care,[33] although our own data showed Chinese and non-Chinese patients had equivalent timely referral and vessel adequacy.

Our findings seem to agree more with those from Weale et al.[34] In their large, multiethnic cohort in which 15% of patients but no nonwhites were aged >80 years and 92% received a primary RCAVF or BCAVF, 2-year SP in those two accesses was 27.1% vs 36% and 33.6% vs 39.2% in elderly and nonelderly, respectively. Nonmaturation was 46% in RCAVFs, and female sex and dialysis initiation with a TC were associated with nonmaturation. This further reinforces our argument that the differences between our outcomes and those of other publications are more due to patient and access selection rather than center-specific technical issues. We did show comparable demographic and clinical characteristics between elderly patients who received AVFs and those exclusively dialyzed by TC, indicating our elderly cohort was not overselected and was representative of the average patients starting dialysis at our center.

Our RCAVF rate was high (59%), as was the case in three other studies[15,28,34] due perhaps to adequate preoperative vein capital preservation and our center-specific, distal AVF-first focus. RCAVF patency rates were comparable to those of upper arm AVF despite a recent meta-analysis conclusion that such accesses have inferior outcomes in the elderly.[35] However, a distal AVF-first approach needs to be backed by an aggressive vein capital preservation preoperatively and surveillance and intervention strategy postoperatively to reduce and address its high failure rate. We also showed AVFs in the elderly, despite having a higher technical failure rate after PTA, have comparable cumulative survival overall after PTA to nonelderly and hence should not be denied salvage interventions. Interestingly, lack of association between age and nonmaturation from our cohort indicates that preoperative nonmaturation scoring[16] does not have much application in our population, implying routine clinical examination and monitoring should remain the standard of care.

Several limitations, however, deserve mention. This was a retrospective single-center study in Asia and may therefore lack external generalizability. Other outcome risk factors, such as body mass index, smoking history, and actual vessel size, as well as experience of the surgeons, nursing skills, and techniques in AVF cannulation, dialysis adequacy, and intradialytic hypotension, were not analyzed. The standard mean error was >10% of the mean estimate in a number of instances because of sample size effect and may have confounded the accuracy of our AVF patency rates. Maturation could have been defined by a more objective criteria such as the Kidney Foundation Disease Outcomes Quality Initiative rule of 6.[12] The use of TC removal as a criterion for maturation meant that delays in TC removal and scheduling of the second stage of BBTAVFs negatively affected maturation rates in especially BBTAVFs. Analysis of early elderly (aged 65-80 years) and late elderly (aged ≥80 years) could have further identified the subgroup most at risk but could not be done due to small sample size. None of these limitations, however, invalidate our findings that AVF survival is similar in elderly and younger incident hemodialysis patients.

CONCLUSIONS

Elderly patients from an aging, multiethnic ESRD population with a high diabetes mellitus burden have equivalent AVF outcomes, procedures, and complications as the nonelderly, regardless of the type of AVF used, although overall nonmaturation remains high. Prior dialysis with a TC, non-Chinese race, and absence of endovascular or surgical interventions are important risk factors for AVF loss, whereas female sex and prior dialysis by catheter significantly affect maturation. Although patient selection is still important, elderly Asian patients suitable for surgery should not be denied any type of AVF solely because of age.

We thank Valerie Ma for organizing and setting up the vascular access database and providing valuable data for the write up of the manuscript.

AUTHOR CONTRIBUTIONS

Conception and design: CR
Analysis and interpretation: CR
Data collection: CR, AV
Writing the article: CR
Critical revision of the article: JH, PR, AV, EL

Final approval of the article: CR, PR, JH, AV
Statistical analysis: CR
Obtained funding: Not applicable
Overall responsibility: CR

REFERENCES

1. ERA-EDTA Registry: ERA-EDTA Registry 2005 Annual Report Amsterdam: Academic Medical Center, Department of Medical Informatics; 2005, June 2007.
2. Di Benedetto A, Basci A, Cesare S, Marcelli D, Ponce P, Richards N. Increased use of catheters as vascular access: is it justified by patients' clinical conditions? J Vasc Access 2007;8:21-7.
3. US Renal Data System. USRDS 2009 annual data report: atlas of chronic kidney disease and end-stage renal disease in the United States. Bethesda: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2009.
4. Nakai S, Masakane I, Akiba T, Iseki K, Watanabe Y, Itami N, et al. Overview of regular dialysis treatment in Japan (as of 31 December 2005). Ther Apher Dial 2007;11:411-41.
5. Ng YY, Wu SC, Hung YN, Ko PJ. Effect of demographic characteristics and timing of vascular access maturation on patency in Chinese incident haemodialysis patients. Nephrol Dial Transplant 2009;24:3447-53.
6. The 7th report of the Singapore Renal Registry 2007-2009. Available at: http://www.nrdo.gov.sg/uploadedFiles/NRDO/SRR_2007_2008_Report_v1.2.0_d20100807.pdf. Accessed 2011.
7. Williams ME. Diabetic CKD/ESRD 2010: a progress report? Semin Dial 2010;23:129-33.
8. Tazza L, Di Napoli A, Bossola M, Valle S, Pezzotti P, Luciani G, et al. Ageing of patients on chronic dialysis: effects on mortality—A 12-year study. Nephrol Dial Transplant 2009;24:940-7.
9. Richardson AI, 2nd, Leake A, Schmieder GC, Biuckians A, Stokes GK, Panneton JM, et al. Should fistulas really be first in the elderly patient? J Vasc Access 2009;10:199-202.
10. Allon M, Lok CE. Dialysis fistula or graft: the role for randomized clinical trials. Clin J Am Soc Nephrol 2010;5:2348-54.
11. Chan MR, Sanchez RJ, Young HN, Yevzlin AS. Vascular access outcomes in the elderly hemodialysis population: a USRDS study. Semin Dial 2007;20:606-10.
12. National Kidney Foundation. K/DOQI Clinical Practice guidelines and Clinical Practice recommendations: 2006 updates. Hemodialysis adequacy, peritoneal dialysis adequacy, vascular access. Available at: http://www.kidney.org/professionals/kdoqi/guideline_uphd_pd_va/index.htm.
13. Tordoir J, Canaud B, Haage P, Konner K, Basci A, Fouque D, et al. EBPG on vascular access. Nephrol Dial Transplant 2007;22 [Suppl 2]:88-117.
14. Brunori G, Verzeletti F, Zubani R, Movilli E, Gaggiotti M, Cancarini G, et al. Which vascular access for chronic hemodialysis in uremic elderly patients? J Vasc Access 2000;1:134-8.
15. Lok CE, Oliver MJ, Su J, Bhola C, Hannigan N, Jassal SV. Arteriovenous fistula outcomes in the era of the elderly dialysis population. Kidney Int 2005;67:2462-8.
16. Lok CE, Allon M, Moist L, Oliver MJ, Shah H, Zimmerman D. Risk equation determining unsuccessful cannulation events and failure to maturation in arteriovenous fistulas (REDUCE FTM I). J Am Soc Nephrol 2001;17:3204-12.
17. Sidawy AN, Gray R, Besarab A, Henry M, Ascher E, Silva M, Jr, et al. Recommended standards for reports dealing with arteriovenous hemodialysis accesses. J Vasc Surg 2002;3:603-10.
18. Gray RJ, Sacks D, Martin LG, Trerotola SO, Society of Interventional Radiology Technology Assessment Committee. Reporting standards for percutaneous interventions in dialysis access. J Vasc Interv Radiol 2003;14:S433-42.
19. Ridao-Cano N, Polo JR, Polo J, Pérez-García R, Sanchez M, Gómez-Campderá FJ. Vascular access for dialysis in the elderly. Blood Purif 2002;20:563-8.
20. Culp K, Taylor L, Hulme PA. Geriatric hemodialysis patients: a comparative study of vascular access. ANNA J 1996;23:583-9.
21. Bonforte G, Zerbi S, Pasi A, Sangali L, Rivera R, Surian M. Distal arteriovenous fistulas in elderly hemodialysis patients. J Vasc Access 2000;1:144-7.
22. Gomez-Campdera FJ, Polo JR, Sanabia J, Tejedor A. First-choice vascular access in patients over 65 years of age starting dialysis. Nephron 1996;73:342-3.
23. Staramos DN, Lazarides MK, Tzilalis VD, Ekonomou CS, Simopoulos CE, Dayantas JN. Patency of autologous and prosthetic arteriovenous fistulas in elderly patients. Eur J Surg 2000;166:777-81.
24. Prischl FC, Kirchgatterer A, Brandstätter E, Wallner M, Baldinger C, Roithinger FX, et al. Parameters of prognostic relevance to the patency of vascular access in hemodialysis patients. J Am Soc Nephrol 1995;6:1613-8.
25. Grapsa EJ, Paraskevopoulos AP, Moutafis SP, Vourliotou AJ, Papadoyannakis NJ, Digenis GE, et al. Complications of vascular access in hemodialysis (HD)–aged vs adult patients. Geriatr Nephrol Urol 1998;8:21-4.
26. Swindlehurst N, Swindlehurst A, Lumgair H, Rebollo Mesa I, Mamode N, Cacciola R, et al. Vascular access for hemodialysis in the elderly. J Vasc Surg 2011;53:1039-43.
27. Jennings WC, Landis L, Taubman KE, Parker DE. Creating functional autogenous vascular access in older patients. J Vasc Surg 2011;53:713-9.
28. Lin SL, Huang CH, Chen HS, Hsu WA, Yen CJ, Yen TS. Effects of age and diabetes on blood flow rate and primary outcome of newly created hemodialysis arteriovenous fistulas. Am J Nephrol 1998;18:96-100.
29. Dukkipati R, de Virgilio C, Reynolds T, Dhamija R. Outcomes of brachial artery-basilic vein fistula. Semin Dial 2011;24:220-30.
30. Dember LM, Beck GJ, Allon M, Delmez JA, Dixon BS, Greenberg A, et al. Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis: a randomized controlled trial. JAMA 2009;299:2164-71.
31. Turmel-Rodrigues L, Mouton A, Birmelé B, Billaux L, Ammar N, Grézard O, et al. Salvage of immature forearm fistulas for haemodialysis by interventional radiology. Nephrol Dial Transplant 2001;16:2365-71.
32. Ravani P, Brunori G, Mandolfo S, Cancarini G, Imbasciati E, Marcelli D, et al. Cardiovascular comorbidity and late referral impact arteriovenous fistula survival: a prospective multicenter study. J Am Soc Nephrol 2004;15:204-9.
33. Arce CM, Mitani AA, Goldstein BA, Winkelmayer WC. Hispanic ethnicity and vascular access use in patients initiating hemodialysis in the United States. Clin J Am Soc Nephrol 2012;7::289-96.
34. Weale AR, Bevis P, Neary WD, Boyes S, Morgan JD, Lear PA, et al. Radiocephalic and brachiocephalic arteriovenous fistula outcomes in the elderly. J Vasc Surg 2008;47:144-50.
35. Lazarides MK, Georgiadis GS, Antoniou GA, Staramos DN. A meta-analysis of dialysis access outcome in elderly patients. J Vasc Surg 2007;45:420-6.

Submitted Dec 9, 2011; accepted Jan 26, 2012.